THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles melanochir*) from Central America, presented by Mr. D. R. Comyn; two Prairie Marmots (*Cynomys ludovicianus*) from North America, presented by Mr. W. G. Marshall; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, West Indies, presented by Mr. G. Dundas, C.M.Z.S.; a Cuvier's Podargus (*Podargus cuvieri*) from Australia, presented by Mr. R. S. C. Baber; a Lesser Long-eared Bat (*Plecotus brevimanus*), British Isles, presented by Mr. J. Ward; a three-toed Amphiuma (*Amphiuma means*) from North America, presented by Mr. A. C. Cole; a Bonnet Monkey (*Macacus radiatus*) from India, an Egyptian Cat (*Felis chaus*) from North Africa, a Common Ass (*Asinus vulgaris*) from Persia, a Grey-headed Porphyris (*Porphyris poliocephalus*) from South Asia, a Puff Adder (*Vipera arietans*) from the Cape of Good Hope, deposited.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1]

AMONG the many explosive preparations which have during the last thirty years been proposed as substitutes for gunpowder, on account of greater violence and other special merits claimed for them, not one has yet competed with it successfully as a propelling agent, nor even as a safe and sufficiently reliable explosive agent for use in shells; for industrial applications and for very important military or naval uses, dependent upon the destructive effects of explosives, it has had, however, to give place, to a very important extent, and in some instances altogether, to preparations of gun-cotton and nitro-glycerine.

But there appeared little prospect that either gun-cotton or nitro-glycerine, whether used in their most simple condition or in the forms of various preparations, would assume positions of practical importance as explosive agents of reliable, and therefore uniformly efficient, character, until the system of developing their explosive force through the agency of a detonation, instead of through the simple agency of heat, was elaborated.

Before the first step in this important advance in the application of explosive agents was made by Alfred Nobel, about twelve years ago, the very variable behaviour of such substances as gun-cotton and nitro-glycerine, when exposed to the heat necessary for their ignition under comparatively slight modifications of attendant conditions (*e.g.* as regards the completeness and strength of confinement or the position of the source of heat with reference to the main mass of the material to be exploded) rendered them uncertain in their action, and at any rate, only applicable under circumstances which confined their usefulness within narrow limits. The employment by Nobel of an initiative detonation, produced by the ignition of small quantities of mercuric fulminate or other powerful detonating substances, strongly confined, for developing the violent explosion, or detonation, of nitro-glycerine, opened a new field for the study of explosive substances, and the first practical fruit was the successful application of plastic preparations of nitro-glycerine and of compact forms of compressed gun-cotton, with simplicity and certainty, to the production of destructive effects much more considerable than could be accomplished through the agency of much larger amounts of gunpowder, applied under the most favourable conditions. Whereas very strong confinement has been essential for the complete explosion of these substances, so long as the only known means of bringing about their explosion consisted simply of the application of fire or sufficient heat, no confinement whatever is needed for the development, with certainty, of a decidedly more violent explosive action than they are capable of exerting when thus applied, if they are detonated by submitting some portion of the mass to the blow or concussion developed by a sharp detonation, such as is produced by the ignition of a small quantity of strongly confined mercuric fulminate.

The conditions essential to the development of detonation in masses of nitro-glycerine and gun-cotton, or preparations of them, and the relations to and behaviour towards each other of these and other explosive bodies, in their character or functions as detonating agents, have been made the subject of study by the lecturer during the last ten years, and some of the earlier results published by him in connection with this subject also led to the pursuit of experimental inquiries of analogous character by Champion and Pellet and others.

Some of the chief results attained by Mr. Abel's experiments may be briefly summarized.

It was found that the susceptibility to detonation, as distinguished from explosion, through the agency of an initiative detonation, is not confined to gun-cotton, nitro-glycerine, and preparations containing those substances, but that it is shared, though in very different degrees, by all explosive compounds and mixtures.

It was demonstrated that the detonation of nitro-glycerine and other bodies, through the agency of an initiative detonation, is not ascribable simply to the direct operation of the heat developed by the chemical changes of the charge of detonating material, and that the remarkable property possessed by the sudden explosion of small quantities of certain bodies (the mercuric and silver fulminates) to accomplish the detonation of nitro-glycerine and gun-cotton, is accounted for satisfactorily by the mechanical force thus suddenly brought to bear upon some part of the mass operated upon. Most generally, therefore, the degree of facility with which the detonation of a substance will develop similar change in a neighbouring explosive substance, may be regarded as proportionate to the amount of force developed *within the shortest period of time* by that detonation, the latter being in fact analogous in its operation to that of a blow from a hammer or of the impact of a projectile.

Thus, explosive substances which are inferior to mercuric fulminate in the suddenness, and the consequent momentary violence of their detonation, cannot be relied upon to effect the detonation of gun-cotton, even when used in comparatively considerable quantities. Percussion cap composition, for example, which is a mixture of fulminate with potassium chlorate, and is therefore much less rapid in its action than the pure fulminate, must be used in comparatively large quantities to accomplish the detonation of gun-cotton.

The essential difference between an explosion and what we now distinguish as a detonation lies in the comparative suddenness of the transformation of the solid or liquid explosive substance into gas and vapour.

The gradual nature of the explosion of gunpowder is illustrated, in its extreme, by burning a train of powder in open air; the rapidity and consequent violence of the explosion is increased in proportion to the degree of confinement of the exploding charge, or to the resistance opposed to the escape or expansion of the gases generated upon the first ignition of the confined substance.

In the case of a very much more sensitive and rapidly explosive substance than gunpowder, such as mercuric fulminate, the increase in the rapidity of its transformation, by strong confinement, is so great that the explosion assumes the character of a detonation in regard to suddenness and consequent destructive effect. A still more sensitive and rapidly explosive material (such as the silver fulminate and iodide of nitrogen) produces when exploded in open air effects akin to those of detonation; yet even with these bodies, confinement operates in increasing the rapidity of the explosive to suddenness, and consequently in developing a more purely detonative action.

Detonation, developed in some portion of a mass, is transmitted with a velocity approaching instantaneousness throughout any quantity, and even if the material is laid out in the open air in long trains composed of small masses. The velocity with which detonation travels along trains thirty or forty feet in length, composed of distinct masses of gun-cotton and of dynamite, has been found to range from 17,000 to 24,000 feet per second. Even when trains of these explosive agents were laid out with intervening spaces of half an inch between the individual masses composing the trains, detonation was still transmitted along the separated masses with great though diminished velocity.

The suddenness with which detonation takes place has been applied as a very simple means of breaking up shells into small fragments and scattering these with considerable violence, with employment of very small charges of explosive agent. Thus by filling a 16-pr. common shell completely with water and inserting a charge of ½ oz. of gun-cotton fitted to a detonating fuze, the shell being thoroughly closed by means of a screw plug, the force developed by the detonation of the small charge of gun-

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[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author.

cotton is transmitted instantaneously in all directions by the water, and the shell is thus broken up into a number of fragments averaging fourteen times the number produced by bursting a shell of the same size by means of the full amount of powder which it will contain (13 oz.). Employing 1 oz. of powder, in place of ½ oz. of gun-cotton, in the shell filled with water, the comparatively very gradual explosion of the powder charge is rendered evident by the result; the shell being broken up into less than twenty fragments by the shock produced by the first ignition of the charge, transmitted by the water. In this case the shell is broken up by the minimum amount of force necessary for the purpose, before the explosive force of the powder charge is properly developed. Extensive comparative experiments carried on not long since by the Royal Artillery at Okehampton, demonstrated that this simple expedient of filling common shells with water and attaching a small charge of gun-cotton with its detonator to the fuse usually employed, allowed of their application as efficient substitutes for the comparatively complicated and costly shrapnel and segment shells.

Another illustration of the sharpness of action developed by detonation as compared with explosion, consequent upon the almost instantaneous character of the metamorphosis which the explosive agent undergoes in the case of detonation, is afforded by a method which the lecturer applied some years since for comparing the violence of action of charges of gun-cotton and of dynamite arranged in different ways. The charges (5 lb.) to be detonated were freely suspended over the centres of plates of very soft steel of the best quality, which rested upon the flat face of a massive block, or anvil, of iron, having a large central circular cavity. The distance between the upper surface of the plate and the charge suspended over it, was 4 feet. The sharp blow delivered upon the plate by the air suddenly projected against it by the force of the detonation when the charge was fired, forced the metal down into the cavity of the anvil, producing cup-shaped indentations, the dimensions of which afforded means of comparing the violence of the detonation. A much larger charge of powder exploded in actual contact with the plate, would produce no alteration of form in the metal, and the same negative result would be furnished by the explosion over the plate of a heap of loose gun-cotton of the same or greater weight than the charges detonated. The above method of experiment was devised, in the first instance by Mr. Abel, in July 1875, for comparing the quality of some specimens of Llandore steel proposed to be used by the Admiralty for ship-building purposes, with samples of malleable iron, and it has since been employed by Mr. Adamson in carrying out a very useful series of experiments, recently communicated to the Iron and Steel Institute.

It has been stated that detonation can be transmitted from one mass of gun-cotton or dynamite to another through intervening air-spaces. The extent to which such spaces can be introduced without checking detonation is obviously regulated by the size of the masses of explosive detonated; but the distances of air-space through which the detonation of a moderate quantity of the explosive agent will communicate to similar masses, are very limited, a space of 2 inches being sufficient to prevent the detonation produced by a mass of 8 oz. of gun-cotton, freely exposed, from communicating to contiguous ones. If the dispersion of force is prevented in part, and direction is given to the gases violently projected from the centre of detonation, the power of transmitting detonation to separated masses of explosive is increased to a remarkable degree. This is readily accomplished through the agency of tubes, the charge first detonated being just inserted into one extremity, while that to which the detonation is to be transmitted is inserted into the other; or separate charges may be placed at different distances inside a long tube, with long intervening spaces, the initiative charge being inserted at one end. Thus, the detonation of a 1-oz. disk of gun-cotton in open air will not transmit detonation with *certainty* to other disks placed at a greater distance than half an inch from it; but if it be just inserted into one end of an iron tube 2 feet long and 1·25 inch in diameter, a similar disk, inserted into the other extremity of the tube, will invariably be detonated. In tubes of the same kind, of very considerable length, 2-oz. disks of gun-cotton placed at intervals of 2 feet, were detonated through the initiative detonation of one such disk inserted into one extremity of the tube. The results obtained with equal quantities of gun-cotton varied with the diameter, strength, and nature of the material of the tubes used. Dynamite and mercuric fulminate, applied to their own detonation, furnished results quite analogous to those obtained with gun-cotton; but in applying fulminate to the detonation of gun-cotton through the agency of tubes, some singularly exceptional results were obtained.

Silver fulminate was employed for the purpose of instituting more precise experiments than could be made in operating on a larger scale, with gun-cotton, on the influence of the material composing the tubes, of the condition of their inner surfaces, and of other variable circumstances, upon the transmission of detonation. Half a grain of silver fulminate freely exposed and ignited by a heated body, will transmit detonation to some of the compound placed at a distance of 3 inches from it, but does not do so with certainty through a distance of 4 inches. But when the quantity of the fulminate is just inserted into one end of a stout glass tube 0·5 inch in diameter, and 3 feet long, its detonation is invariably induced by that of a similar quantity of the fulminate placed just inside the other extremity of the tube. Glass tubes were found to transmit the detonation of silver fulminate much more rapidly than tubes of several other materials of the same diameter and thickness of substance. Thus, with the employment of double the quantity of fulminate required to transmit the detonation with certainty through a glass tube of the kind described, 3 feet in length, it was only possible to obtain a similar result through a pewter tube 31·5 inches long, a brass tube 23·7 inches long, an indiarubber tube 15·8 inches long, and a paper tube 11·8 inches long. The difference in the results obtained was not ascribable to a difference in the escape of force on the instant of detonation, in consequence of the fracture of the tube, nor to the expenditure of force in work done upon the tube at the seat of detonation. The transmission of detonation appeared also not to be favoured by the sonorosity or the pitch of the tube employed, as the sonorous brass tube was not found to favour the transmission to the same extent as the pewter tube. These differences appeared on further investigation not to be ascribable, to any important extent, if at all, to the difference in the nature of the material composing the tubes, but to be simply, or at any rate almost entirely, due to differences in the condition of the inner surfaces of the tubes. Thus, brass tubes, the inner surfaces of which were highly polished, and paper tubes, when coated inside with highly glazed paper, transmitted the detonation of the silver fulminate to about the same distance as the glass tubes; on the other hand, when the inner surfaces of the latter were slightly roughened by coating them with a film of fine powder, such as French chalk, they no longer transmitted detonation to anything like the distance which they did when the inner surfaces were in the normally smooth condition. Other very slight obstacles to the unimpeded passage of the gas wave through the tubes were found greatly to reduce the facility with which detonation could be transmitted by means of tubes; thus, when a diaphragm of thin bibulous paper was inserted into the glass tube about half-way between the two extremities, detonation was not transmitted, even with the employment of about six times the quantity of fulminate that gave the result with certainty under ordinary conditions.

Among several other interesting results furnished by an examination into the conditions governing and results attending the transmission of detonation by tubes, a remarkable want of reciprocity was found to exist between mercuric fulminate and gun-cotton. The latter substance is more susceptible to the detonative power of mercuric fulminate than of any other substance. The quantity of fulminate required to detonate gun-cotton is regulated by the degree to which the sharpness of its own detonation is increased by the amount of resistance to rupture offered by the envelope in which the fulminate is confined. From 20 to 30 grains are required if the detonative agent is confined in a thin case of wood, or in several wrappings of paper; but as small a quantity as 2 grains of the fulminate suffices to effect the detonation of compressed gun-cotton, provided the fulminate be confined in a case of stout metal (sheet tin) and be closely surrounded by being tightly imbedded in the mass of gun-cotton. If there be no close contact between the two, the quantity of fulminate must be very considerably increased to ensure the detonation of the gun-cotton, and, in attempting to transmit detonation from mercuric fulminate to gun-cotton by means of tubes, it was found necessary to employ comparatively very large quantities of fulminate in order to accomplish this, even through short lengths of tubes. But when the quantity of fulminate used reaches certain limits, the detonation may be transmitted from it to gun-cotton through very long lengths of tube. In applying gun-cotton, on the other hand, to accomplish the detonation of mercuric fulminate, it was found that this result could be attained, and through considerable lengths of tube (7 feet and upwards) by means of very much smaller quantities of gun-cotton than is needed of fulminate to induce the detonation of gun-cotton through the corresponding distances.

This want of reciprocity between two detonating agents corresponds to one even more remarkable, which was observed by the lecturer in his earlier investigations on this subject. In the first place it was found that the detonation of ¼ oz. of gun-cotton (the smallest quantity that can be thus applied) induced the simultaneous detonation of nitro-glycerine, inclosed in a vessel of sheet tin and placed at a distance of 1 inch from the gun-cotton; while with ½ oz. of the latter, the same effect was produced with an intervening space of 3 inches between the two substances. But on attempting to apply nitro-glycerine to the detonation of gun-cotton, the quantity of the former, which was detonated in *close contact* with compressed gun-cotton, was gradually increased in the first instance to ¾ oz. and subsequently even to 2 oz. without accomplishing the detonation of the latter, which was simply dispersed in a fine state of division, in all instances but one in a large number of experiments.

The force developed by the detonation of nitro-glycerine was proved to be decidedly greater than that of the fulminate, of which from 2 to 5 grains suffice for developing the detonation of gun-cotton, when it is in close contact with them. The non-susceptibility of gun-cotton to detonation by nitro-glycerine is therefore, it need scarcely be said, not ascribable to any deficiency in mechanical force suddenly applied when the nitro-glycerine is detonated.

(*To be continued.*)

INTELLECT IN BRUTES

FROM several additional letters which we have received on this subject we select the following:—

Mr. Claypole, of Antioch College, Ohio, writes:—A friend of mine is employed on a farm near Toronto, Ontario, where a horse belonging to the wife of the farmer is never required to work, but is allowed to live the life of a gentleman for the following reason: Some years ago the lady above-mentioned fell off a plank bridge into a stream where the water was deep. The horse, which was feeding in a field close by, ran to the spot and held her up with his teeth till assistance arrived, thus probably saving her life. Was this reason or instinct? Again, a gentleman engaged in the business of distilling at Cincinnati has more than once told me that the rats in his distillery are in the habit of drinking any spirits spilt on the ground or left in open vessels, and that they often become, in consequence, so tipsy that they cannot run, and are easily taken by hand. Which is this?

Mr. J. J. Furniss, of New York, writes:—Since the publication of my letter (NATURE, vol. xix. p. 385) on the evidence of reasoning power in an elephant, afforded by the fact that he thatched his back with grass when exposed to the heat of the sun, I have received additional data bearing on the subject from Mr. W. A. Conklin, the superintendent of the Central Park Menagerie. I am informed by him that he has frequently observed elephants, when out of doors in the hot sunshine, thatch their backs with hay or grass; that they do so to a certain extent when under cover in the summer time, and when the flies which then attack the animals, often so fiercely as to draw blood, are particularly numerous; but that they never attempt to thatch their backs in the winter. This seems to prove that they act intelligently, and for the attainment of a definite end. It would be interesting to learn whether elephants in their wild state are in the habit of so thatching their backs. It seems more probable to suppose that in their native wilds they would avail themselves of the natural shade afforded by the jungle, and that the habit is one which has been developed in consequence of their changed surroundings in captivity. I am also informed by Mr. Conklin that when taken to the water in summer the elephants first sprinkle their bodies all over with water, and then quench their thirst. They never so sprinkle themselves in cold weather. Their reasoning in this case seems to be, "I cool my mouth by pouring water into it, now if I pour water over my back it will cool that also." Am I not justified in calling this "abstract" reasoning?

Mr. Charles Stewart, of Tighnduin by Killin, Perthshire, sends the following story:—A few years ago I kept a collie dog named "Bodach" at my farm, for herding the milk cows, and who recognised the dairy-maid as his mistress. On her directing him to keep the cows on a certain part of a field, he would lay himself down in the centre of a line fixed by him as the proper limit. Patiently and vigilantly he would remain in quietness until any of the cows passed his limit, when he would swoop down on the trespasser, take her by the heels, and drive her back. It was wonderful in how short a time the cows came to recognise and respect the arrangement. He also came to know some of the cows by name. One of them named "Aggi" required at certain seasons to be milked oftener than the others, and the dairymaid had only to say in Gaelic "Bodach, go and bring home Aggi," when he would start for the pasture, single out Aggi, and bring her carefully home.

O. J. H. sends the following:—An ordinary domestic cat was equally fond of a friend of mine and of myself. As a test, we resolved to try the following experiment. We each held a piece of bread, of the same size, shape, &c., above the eyes of the animal. He looked at each hand and its contents alternately, attempting to solve the problem of getting at the bread without exhibiting partiality for either of his friends. He at last seemed to decide upon an expedient, for, raising himself upon his hind legs, he simultaneously seized a piece of bread in each of his front paws, and conveyed the food thus obtained to his mouth. On repeating the experiment after a lapse of some time, no difficulty was experienced in dealing with the matter, as the expedient just mentioned was resorted to without a moment's hesitation.

Prof. Nipher, of Washington University, St. Louis, U.S., writes:—A friend of mine living at Iowa City, had a mule, whose ingenuity in getting into mischief was more than ordinarily remarkable. This animal had a great liking for the company of an oat-bin, and lost no opportunity, when the yard gate and barn-door were open, to secure a mouthful of oats. Finally the mule was found in the barn in the morning, and for a long time it was impossible to discover how he had come there. This went on for some time, until the animal was "caught in the act." It was found that he had learned how to open the gate, reaching over the fence to lift the latch, and that he then effectually mystified his masters, by turning round, and backing against it, until it was latched. He then proceeded to the barn-door, and pulling out the pin which held the door, it swung open of its own accord. From the intelligence which this animal displayed on many occasions, I am of the opinion that had not discovery of his trick prevented, it would soon have occurred to him to retrace his steps before daylight, in order to avoid the clubbing which the stable boys gave him in the morning. It may be added that this animal had enjoyed no unusual educational advantages, and his owners found it to their interest to discourage his intellectual efforts as much as possible.

The Rev. George Henslow endeavours to sum up as follows from the stories that have already appeared:—I am quite ready to admit that more than one instance (notably Dr. Frost's cat, which spread crumbs to catch birds, and which is paralleled by one mentioned in Wood's "Natural History," which "chirped" like a sparrow, and so enticed and caught them), if correctly stated, and *if the motive* of the animals could in every case be proved, will completely overthrow my supposition that animals never copy us with the same or a rational purpose. I cannot help thinking, however, that such cases are very rare. Moreover, I will abandon my notion of abstract reasoning, at least, as hitherto described, for I now think that what I meant by the want of the faculty would be better described as an impotence, or, at least, a feebleness of mind in concatenating correlative ideas; or, perhaps, a want of a receptivity of the suggestiveness of things will express my meaning. On the other hand, I still see no reason for believing that animals can conceive of a purely abstract idea. Thus, "V. I." says a mule would turn on a tap, but did not turn it off again. The reason I would suggest is that *wastefulness* being an abstract conception, the mule could not entertain it. If this be correct, we may now proceed a step further. The idea of a personal *Ego* is purely abstract; hence I am led to believe that no animals can be *self-conscious*, and as a direct consequence, they cannot be either moral or immoral, but are simply automata and non-moral. Like children, they can learn by being scolded, when they displease their master, so that a conscience similar to a child's can be produced in them;